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Incorporation of artificial intelligence toward carbon footprint management in hotels to create sustainable, green hotel: Mini review

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Keywords: Artificial intelligence; Carbon footprint management; Green hotel

Abstract: Managing carbon footprints in hotels is a critical element of ensuring sustainability within the industry. Studies conducted in various settings emphasize the significance of enhancing energy efficiency, particularly within housekeeping departments and electricity usage. The current study employed a comprehensive approach by searching multiple databases including Web of Science Core Collection, SCOPUS, CNKI, and Semantic Scholar to gather relevant literature. As a consequence, just 4 papers fit the criteria and were included in this mini review after 10 unavailable publications and 16 articles irrelevant to the subject were disregarded. Ultimately, the infusion of AI technology into hotels' carbon footprint reduction and management strategies is revolutionizing the industry. With its capacity to optimize energy consumption, revolutionize resource management, curtail embodied carbon, champion sustainable practices, and propel waste reduction endeavors, AI is unleashing a wave of innovation to tackle the environmental hurdles confronting the hospitality sector.

1. Introduction

A carbon footprint refers to the collective emissions of greenhouse gases, primarily carbon dioxide, resulting from human activities. It encompasses various sectors like transportation, energy consumption, and manufacturing. The objective behind mitigating carbon footprints is to combat climate change and decrease the amount of greenhouse gases present in the atmosphere [1]. Industries and technologies are actively seeking ways to diminish their carbon footprints. For instance, one research study investigated the carbon footprint of recycled nanofiltration membranes employed in water treatment, while another examined how additive manufacturing technology could reduce the carbon footprint associated with bearing design [2]. Strategies for reducing carbon footprints encompass utilizing renewable energy sources, enhancing energy efficiency, and minimizing waste generation.

Managing carbon footprints in hotels is a critical element of ensuring sustainability within the industry. Factors driving the adoption of carbon footprint analysis include corporate responsibility, environmental concerns, eco-certification requirements, and associated business benefits. However, challenges such as data gathering difficulties, the absence of a standardized methodology, prolonged decision-making processes, and limited resources hinder its widespread implementation [3]. Studies

conducted in various settings emphasize the significance of enhancing energy efficiency, particularly within housekeeping departments and electricity usage. Additionally, fostering a sense of corporate social responsibility and altruistic values among hotel employees positively influences their pro-environmental behavior. Efforts to measure carbon performance in construction activities provide valuable benchmarks for carbon emissions. In Portugal, low adoption rates of renewable energy innovations in hotels are primarily attributed to unfavorable market conditions, while hotel characteristics, ownership, and opinions about carbon footprint reduction in tourist accommodations do not significantly impact adoption levels [4]. These diverse research insights contribute to the advancement of effective carbon footprint management in the hotel industry.

2. Methods

The current study employed a comprehensive approach by searching multiple databases including Web of Science Core Collection, SCOPUS, CNKI, and Semantic Scholar to gather relevant literature. A search string was formulated using specific keywords such as 'artificial intelligence', 'carbon footprint management', 'sustainable hotel', and 'green hotel' to narrow down the search. The search was conducted on June 15, 2023, and appropriate BOOLEAN operators were utilized. All retrieved documents were imported into Zotero v.6.0.26 for deduplication and screening. Inclusion criteria were applied, which included English-language articles, freely open access publications, articles published since 2022, journal articles only, and relevance to the topic. Documents that did not meet these criteria were excluded from further consideration. A total of 296 documents were initially identified from the databases, with one document from Web of Science Core Collection, 45 documents from China National Knowledge Infrastructure (CNKI), and 250 documents from Semantic Scholar. No documents were found in SCOPUS.

3. Result

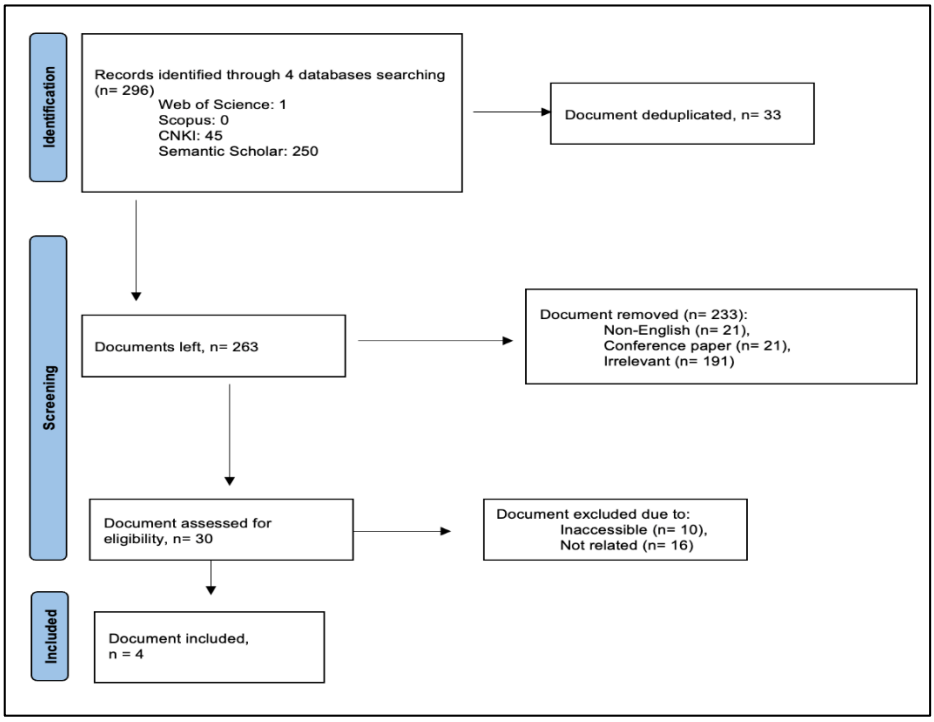

Figure 1: Search Flow – Deduplication and Screening.

After removing 33 duplicate documents, the remaining 263 documents were screened, leading to the elimination of 233 documents due to factors such as non-English language, conference papers, and irrelevant topics. The remaining 30 documents underwent a further assessment for eligibility based on the inclusion criteria. As a consequence, just 4 papers fit the criteria and were included in this mini review after 10 unavailable publications and 16 articles irrelevant to the subject were disregarded. For a graphic illustration of the flow diagram, please see Figure 1.

4. Discussion

Unfortunately, literature regarding incorporation of artificial intelligence toward carbon footprint management are limited. Yet, these 4 articles does provide suggestion and practical implications of artificial intelligence in carbon footprint reduction in hotels.

The advent of Artificial Intelligence (AI) has sparked a paradigm shift in how hotels approach the reduction and management of their carbon footprint, presenting a plethora of innovative possibilities for sustainable practices. The integration of AI technology enables hotels to optimize their energy consumption, enhance resource management, minimize embodied carbon, foster eco-friendly behaviors, and bolster waste reduction initiatives [5]. AI serves as a catalyst for optimizing energy consumption by meticulously analyzing intricate data on energy usage patterns and identifying areas ripe for improvement, such as fine-tuning lighting and HVAC systems in vacant rooms. This intelligent energy management system empowers hotels to tangibly reduce their carbon emissions while simultaneously curbing operational costs [6]. The seamless amalgamation of Internet of Things (IoT) sensors equips hotels with real-time monitoring and control capabilities, affording them unparalleled oversight over diverse operations, including lighting, HVAC, and water usage [7]. By harnessing the power of AI algorithms to scrutinize the amassed data, hotels can discern inefficiencies, make informed decisions, and conscientiously minimize their environmental impact. Another area where AI truly shines is in combating embodied carbon. By harnessing AI during the design and construction phases, hotels can meticulously select materials boasting lower carbon footprints, laying a robust foundation for sustainable practices that will endure for the long haul [6]. AI-driven systems empower hotels to promulgate sustainable practices among their esteemed guests. By imparting precise information pertaining to the environmental repercussions of their stays, hotels can engender a sense of conscientiousness, prompting guests to make eco-conscious choices, such as opting for energy-efficient amenities and actively participating in recycling programs. Waste reduction assumes paramount importance, and AI emerges as an invaluable ally in this realm. AI-powered waste management systems meticulously dissect data pertaining to waste generation, enabling hotels to optimize waste disposal processes, diminish waste volumes, and augment recycling rates, ultimately culminating in a marked reduction in carbon emissions associated with waste management [8].

The convergence of AI technology ushers in a realm of boundless prospects for hotels seeking to astutely govern and mitigate their carbon footprint. By harnessing AI-powered energy management systems, hotels can adroitly fine-tune energy consumption, effectively curtailing their environmental impact. Through the strategic deployment of IoT sensors within multifarious hotel domains, including guest chambers and operational hubs, a profusion of data pertaining to energy and water usage, waste generation, and carbon emissions can be meticulously amassed and subjected to discerning analysis. This invaluable corpus of information serves as a compass, deftly illuminating inefficiencies, delineating sustainability objectives, vigilantly monitoring progress, and empowering guests with comprehensive insights into the ecological repercussions of their sojourn, complete with bespoke recommendations for personal carbon abatement. Additionally, AI augments endeavors to attenuate embodied carbon within hotel edifices, proffering invaluable guidance in the selection of materials that boast diminished carbon footprints. The reduction of waste further reaps rewards from AI's

tenacious embrace, as perceptive data analysis identifies nooks and crannies where waste can be pruned, exemplified by streamlining food production through prescient demand projections. Ultimately, the seamless integration of AI within hotel operations propels the frontiers of carbon footprint management, engendering a resplendent tapestry of sustainable practices that resonates throughout the hospitality industry.

The integration of AI technology to curtail the carbon footprint in hotels presents a myriad of intricate challenges that demand astute navigation. Financial considerations loom prominently as a formidable impediment, particularly for smaller hotels, given the staggering installation costs associated with IoT sensors, energy management systems, and other AI-driven devices. The reliance on technology engenders a delicate tightrope walk, where system failures, network vulnerabilities, and technical glitches hold the potential to unravel the seamless functioning of AI solutions. The delicate dance between data collection and privacy further exacerbates the labyrinth, as concerns regarding the safeguarding of guest information on energy consumption, waste production, and carbon emissions necessitate meticulous compliance with stringent data protection regulations. Persuading recalcitrant hotel operators to embrace the transformative potential of AI technology as a means to alleviate their carbon footprint emerges as a formidable uphill battle, where the resistance to change casts a shadow over the path to progress. Moreover, the successful implementation of AI demands a reservoir of specialized expertise and knowledge, often prompting the pursuit of external consultations or substantial investments in comprehensive employee training. However, amidst these complex challenges, the tantalizing promise of AI to revolutionize the reduction of environmental impact in the hospitality industry beckons as an alluring beacon of hope, compelling stakeholders to embark on this intricate journey of transformation.

5. Conclusion

Ultimately, the infusion of AI technology into hotels' carbon footprint reduction and management strategies is revolutionizing the industry. With its capacity to optimize energy consumption, revolutionize resource management, curtail embodied carbon, champion sustainable practices, and propel waste reduction endeavors, AI is unleashing a wave of innovation to tackle the environmental hurdles confronting the hospitality sector. By harnessing the immense potential of AI, hotels can not only slash their environmental footprint but also supercharge their operational efficiency, paving the way for a future defined by sustainability and success.

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